



Challenges of a minimally invasive approach to posterior liver segments

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We read with particular interest the article by Guro and colleagues which compares the perioperative and long-term survival outcomes between laparoscopic and open liver resection for hepatocellular carcinoma (HCC) located in segments 7 and 8 (1). The topic of laparoscopic liver resection is more than ever of importance, since nowadays we are in a timeframe when technological advancements, new operative techniques and surgical maturity all contribute to a more accessible and safer minimally invasive liver surgery. Currently, the challenge in laparoscopic liver surgery mainly reside in anatomical reasons, i.e., the complex vascular and biliary anatomy, difficult exposure due to size and deep placement of the liver, intrinsic risk of bleeding, and fragile parenchyma, especially in fibrotic and cirrhotic livers (2). Moreover, lesions adjacent to major vessels or near the liver hilum were previously not considered suitable for laparoscopic resection because of the potential risk of massive bleeding and need for biliary reconstruction. Although the advent of conventional laparoscopy represented a major breakthrough in surgical practice, it also confronted the surgeon with some new limitations. Range of motion suddenly reduced from the seven degrees of freedom of the human hand to four; physiologic tremor turned out to be amplified by the laparoscopic instrumentation which was also poor in ergonomics; and finally, reduced visualization. Suturing, knot tying and bimanual tissue manipulation, while considered basic surgical skills in open surgery,

suddenly became advanced surgical skills in laparoscopy, requiring appropriate training and a relatively long learning curve (3). Across the past 10 years, many of those initial problems of laparoscopy have been resolved with the advent of better instrumentation, new surgical techniques and, most importantly, thanks to the increasing surgeons' experience. However, the widespread adoption of the laparoscopic technique in liver surgery was limited by its anatomical position and characteristics, in particular for segments 1, 6, 7 and 8, whom resection is still challenging, even for experienced surgeons (4). This kind of surgery requires nonlinear manipulation during hilar dissection and extensive curved parenchymal transection. Due to the rigidity of conventional laparoscopy, and the difficulty to follow a curved pathway with a straight laparoscope, several techniques have been developed to facilitate resections of the posterosuperior segments. For example, some authors described the advantages of combining transthoracic trocar placement and augmented reality to obtain a more precise triangulation for resection of posterior-superior segments of the liver (5,6). Moreover, it has been proposed that hand control of the liver through a GelPort® (Applied Medical, Rancho Santa Margarita, CA, USA) may allow a better margin of resection in malignant lesions than laparoscopic liver surgery, and direct compression of the dissection surface to reduce blood losses (7). Also of interest in the article by Guro *et al.*, is the retrospective review of the safety of laparoscopic liver resection before and after the

introduction of new dedicated tools and techniques. The article concludes that, nowadays, laparoscopic liver resection is feasible and can be safely performed for neoplastic lesions located in segments seven or eight, thanks to technical improvements and increased experience in the procedure (1). The authors introduced in their practice a peculiar patient positioning on the operating table, the semi-lateral French position, and used an articulating tip camera which allowed for better visualization of the postero-lateral segments. From the literature on this topic, the use of flexible tip camera is documented in most of the experiences of segment 7 and 8 resection. The authors also introduced, in specific contexts, the use of the Pringle maneuver and the placement of intercostal trocars for a facilitated meticulous dissection. On this latter practice, however, a prolonged postoperative stay due to pain has been speculated, but it is generally considered as safe and reproducible (8,9). In our opinion, a major aid for laparoscopic liver surgery could also come from optical 3D systems with flexible tips, especially for surgeons in their early learning curve. The use of 3D system is worth of consideration and, being particularly helpful for complex laparoscopic tasks, its use could reduce intraoperative times, shorten the learning curve and improve safety, thanks to a better visualization. There are also other solutions becoming available, with the aim of overcoming some of the limitations of laparoscopic surgery. One of them is the HandX[®] (Human Xtensions, Netanya, Israel) which is a simplified robotic platform mounted on laparoscopic-like instruments. It is designed as a light-weight, hand-held device that translates the surgeon's natural hand motions into complex movements inside the patient (for further details see: <http://human-x.com/human-xtensions-receives-fda-clearance/>). All these different technical improvements can be found in the current da Vinci[®] robotic platform (Intuitive Surgical, Sunnyvale, CA, USA), with some added benefits. The 3D high-resolution vision with up to 10× magnification, stability of the view, motion filtration and increased comfort for the surgeons are renowned advantages of the robotic platform. Moreover, the possibility to work with flexible instruments makes the robotic system particularly suited for liver resections on posterior segments. The lack of haptic feedback is no longer considered a problem by expert surgeons in robotic surgery, as it is well counterbalanced by the stereoscopic vision. In other words, it seems that the technological growth of laparoscopy is currently aiming to close the gap of comfort for the surgeon as compared to the robotic platform. In our experience, when comparing laparoscopic

and robotic liver resections, the latter resulted in reduced complications, with a shorter learning curve in the setting of a tertiary referral Hepato-Pancreato-Biliary (HPB) center. Notably, there is no formal evidence of superiority of the robotic approach over the laparoscopic one in liver surgery in terms of oncologic outcomes (10).

In conclusion, well trained surgeons in centers with a large experience in the field of laparoscopic liver surgery can safely approach difficult resections. However, the robotic platform currently provides features that makes operating on difficult segments more comfortable for the surgeons.

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